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Abstract

THE PRESENT STATE OF KNOWLEDGE ABOUT CADMIUM- AND INDIUMTANTALATE AS POSSIBLE CONTROL MATERIALS FOR HIGH-TEMPERATURE REACTORS

F. Haessner, G. Petzow and E. Preisler
Max-Planck-Institut für Metallforschung, Stuttgart

Principally cadmiumtantalate and indiumtantalate can be used as absorber materials in high temperature reactors. Compared with boron or boron-containing materials which have almost exclusively been proposed till now for higher temperatures, the tantalates have the advantage in absorbing neutrons by a n,γ-reaction instead of a n,α-reaction. In relation to hafnium, the lanthanons or their oxides or other compounds, which are also interesting materials for higher temperatures, the tantalates are easily available at relatively low costs.

Mixtures made of cadmiumtantalate and indiumtantalate possess an advantageous absorption spectrum for neutrons as well in the thermal as in the epithermal energy region. This spectrum is comparable with that of hafnium or of the silver-indium-cadmium alloys. Furthermore the double-oxides are, with respect to tantalum, also interesting for fast reactors since only the isotope B^{10} can compete with tantalum in that energy range (0.01 MeV up to some MeV).

$Cd_2Ta_2O_7$ has good thermal resistance up to 1000°C, $In_2Ta_2O_8$ even up to 1300°C. The tantalates do not show any phase transformation between room temperature and 950°C (the highest temperature that was investigated). The double-oxides can be prepared easily by annealing the pure components CdO and Ta_2O_5 or In_2O_3 and Ta_2O_5. Cadmiumtantalate is compatible with silver and copper and, up to 700°C, with nickel; indiumtantalate is completely compatible with silver, copper and nickel and up to 700°C also with molybdenum and to some degree with iron. These results are in agreement with thermodynamical calculations.

For an estimation of the behaviour of the materials under reactor conditions the daughter products which originate by neutron absorption have to be considered. Whereas Cd^{113} transforms into the stable Cd^{114}, tantalum is transmuted into tungsten and indium into tin. Both daughter products can bind more oxygen in their most stable valency states than the parent elements. Therefore the reduction of Cd^{++} to metal can be expected while indiumtantalate should be stable. This has been confirmed by experiments with SnO- and WO_2- additions to cadmiumtantalate. Addition of copper (I)oxide to the compounds can suppress this effect.

For the practical use of the tantalates their workability of the pure compounds as well as of a cermet is of importance. While sintered pellets of the pure tantalates which were originally pressed at room temperature cannot be shaped by plastic deformation, there is no difficulty in deforming tantalate-copper cermets in a suitable can up to high degrees. Even after high degrees of deformation the distribution of the tantalate particles remains even, no clustering occurs. This even distribution is not disturbed by a recrystallization treatment of the deformed cermet.

Investigations of the behaviour of the tantalates under reactor conditions are initiated.